IMPACT OF TEMPORAL RESOLUTION OF THREE-DIMENSIONAL ECHOCARDIOGRAPHY ON LEFT VENTRICULAR STRAIN EVALUATION: AN EXPERIMENTAL STUDY

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Background: Strain values derived from 2D echos are a clinical standard for evaluation of cardiac mechanics. 4D echo-based feature-tracking is a promising method for determining strain; however, there are temporal resolution concerns. We endeavored to evaluate the impact of variable frame rate (FR) on the calculation of longitudinal and circumferential strain (LS, CS).

Methods: Five freshly harvested porcine heart phantom models were passively driven by a calibrated pump at stroke volumes (SVs) 30-70 ml. Full-volume data was acquired before and after a simulated myocardial infarction (MI) at two different temporal resolutions (FR = 18 volumes per second [vps] and FR = 30 vps) on a Toshiba Artida 4D Ultrasound System. LS and CS values were calculated from the 4D echo data then evaluated against sonomicrometry.

Results: LS and CS derived from high FR volume acquisitions show a superior correlation with sono data (LS: $R^2 = 0.8764$, CS: $R^2 = 0.657$) than strain values from low FR (LS: $R^2 = 0.7758$, CS: $R^2 = 0.6123$). Bland-Altman analyses demonstrate decreased overestimation of LS and CS at high FR (LS: 6.4272, CS: 7.8349) compared to low FR (LS: 6.9004, CS: 8.1647) with 96% of points within a 95% CI for both. At high and low FRs, LS and CS displayed excellent correlations with sono and were significantly decreased after MI induction (All $p<0.001$).

Conclusion: Myocardial segmental strain is accurately evaluated by values determined from 4D echo volumes. Strain from higher temporal resolution data was found to be more precise.